Patent claims

1. A process for producing a composite material, in which at least two materials with different refractive indices occur in a substantially periodic sequence along all three spatial directions, the structure of the composite material being produced using at least one structure-directing building block in the style of a template as a three-dimensional copy thereof.

2. The process as claimed in claim 1, characterized in that the structure of the composite material is composed of three-dimensionally arranged, preferably substantially spherical particles.

3. The process as claimed in claim 1 or claim 2, characterized in that the composite material includes two materials whereof the refractive index differs by at least two units from one another ($\Delta n \geq 2$).

4. The process as claimed in one of claims 1 to 3, comprising the following steps:

a) producing a primary template, which has a structure made up of three-dimensionally arranged, preferably substantially spherical particles with cavities (interstices) between these particles,

b) filling the cavities of the primary template with a curable material and curing the curable material,

c) removing the primary template in order to produce a structure which represents a three-dimensional negative of the structure of the primary template,

d) filling the cavities in the secondary template with at least one precursor of an inorganic oxide,

e) hydrolyzing the precursor and converting it into the inorganic oxide by means of a pressure and/or heat treatment,

f) removing the secondary template to produce a three-dimensional copy of the primary template

composed of oxide particles.

5. The process as claimed in claim 4, characterized in that the oxide particles of the structure which results from f) are substantially completely covered with a metal, in particular with Cu, Ag, Au, Pt or Pd, or an alloy of these metals.

6. The process as claimed in claim 5, characterized in that the cavities in the resulting structure are at least partially filled with the metal.

7. The process as claimed in one of claims 4 to 6, characterized in that the primary template is produced by a self-organization route.

8. The process as claimed in one of claims 4 to 7, characterized in that the primary template is a colloidal SiO_2 crystal template.

9. The process as claimed in one of claims 4 to 8, characterized in that the primary template is removed by chemical or physical dissolution, preferably using a basic solution, in particular using sodium hydroxide solution, or using an acidic solution, in particular using hydrofluoric acid.

10. The process as claimed in one of claims 4 to 9, characterized in that the curable material is a polymerizable compound or composition, in particular methyl methacrylate.

11. The process as claimed in one of claims 4 to 10, characterized in that the inorganic oxide is Al_2O_3, ZrO_2, Fe_2O_3 or TiO_2.

12. The process as claimed in one of claims 4 to 11, characterized in that the precursor is preferably an

alkoxide oligomer of a metal preferably selected from the group consisting of Al, Zr, Fe or Ti.

13. The process as claimed in one of claims 4 to 12, characterized in that the inorganic oxide is doped, preferably with Al, Ga, Gd, Sn and/or Ge.

14. The process as claimed in claim 13, characterized in that the doped inorganic oxide is produced from a single-source precursor.

15. The process as claimed in one of claims 4 to 14, characterized in that the heat treatment in accordance with step e) is carried out at temperatures of < 250°C, in particular between 180°C and 250°C.

16. The process as claimed in one of claims 4 to 15, characterized in that the pressure treatment in accordance with step e) is carried out at pressures of > 1 bar, in particular between 2 bar and 50 bar.

17. The process as claimed in one of claims 4 to 16, characterized in that the secondary template is removed by chemical or physical dissolution, preferably by means of an organic solvent, in particular by means of acetone, ethyl acetate, tetrahydrofuran and/or dimethylformamide.

18. The process as claimed in one of claims 5 to 17, characterized in that the covering of the oxide particles with a metal is carried out by a wet-chemical route.

19. The process as claimed in one of the preceding claims, characterized in that the resulting particles of the structure of the composite material are core-shell particles.

20. The process as claimed in claim 19, characterized in that the core of the core-shell particles substantially comprises TiO_2 and the shell substantially comprises silver.

21. The process as claimed in one of claims 2 to 20, characterized in that the particles are nanoparticles with a particle size of < 500 nm, preferably < 250 nm.

22. A composite material, produced by the process as claimed in one of the preceding claims.

23. A composite material, producible by the process as claimed in one of claims 1 to 21.

24. The composite material as claimed in one of claims 22 or 23, characterized in that it has a structure of three-dimensionally arranged, substantially spherical particles, and at least two materials with different refractive indices occur in a periodic sequence along all three spatial directions.

25. The composite material as claimed in claim 24, characterized in that the substantially spherical particles are what are known as core-shell particles.

26. The composite material as claimed in claim 25, characterized in that the core is an inorganic oxide, preferably Al_2O_3, ZrO_2, TiO_2 and/or Fe_2O_3.

27. The composite material as claimed in claim 25 or claim 26, characterized in that the shell is metallic, preferably formed from Cu, Ag, Au, Pt or Pd or an alloy of these metals.

28. The composite material as claimed in one of claims 25 to 27, characterized in that the core of the core-shell particles substantially comprises TiO_2 and

the shell substantially comprises silver.

29. The composite material as claimed in one of claims 25 to 28, characterized in that the core is doped, preferably with Al, Ga, Gd and/or Ge.

30. The composite material as claimed in one of claims 24 to 29, characterized in that it includes two materials whereof the refractive index differs by at least two units from one another ($\Delta n \geq 2$).

31. The use of the composite material as claimed in one of claims 22 to 30 as what is known as a photonic crystal, preferably in high-power miniature lasers, optical fibers, ultra-white pigments, RF antennas and reflectors, LEDs or in photonic circuits.